



Longevity in Asia-Pacific populations

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Explore the patterns in the historic data

Compare mortality trends in a selection of Asia-Pacific populations to Europe and North America



Fit a selection of industry models

UK (CMI), US (MIM), and the Netherlands (AG)



Assess the recent emerging data from 2020+

Differences in mortality experience during the pandemic period and beyond



Challenges in interpreting emerging mortality



Conclusions

Comparing Asia - Pacific Region to Europe / North America



		Population (million)	ASMR % Males	ASMR % Females
Europe / US 	United Kingdom	66	2.79	2.04
	Netherlands	17	2.80	2.06
	United States	327	3.02	2.12
Asia - Pacific 	Australia	25	2.35	1.66
	New Zealand	5	2.60	1.94
	Japan	124	2.44	1.29
	Taiwan	24	2.96	1.90
	Hong Kong	7	2.18	1.25
	South Korea	51	2.66	1.50

Includes populations in the Human Mortality Database¹

2019 statistics
("pre-pandemic" view)

ASMRs = age-standardised mortality rates for ages 50-100 (European Reference Population²)

Population distributions vary between the populations and over time

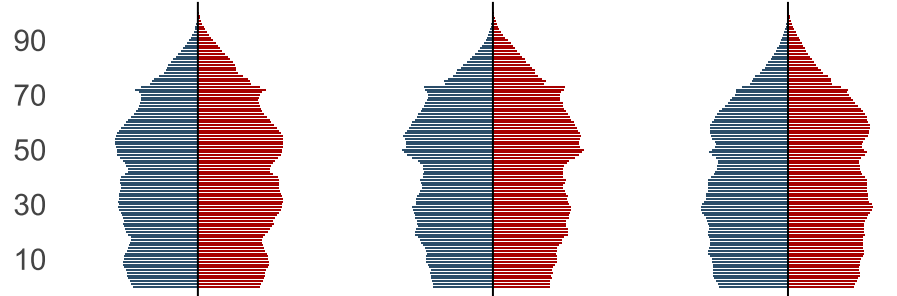


2020

United Kingdom

Netherlands

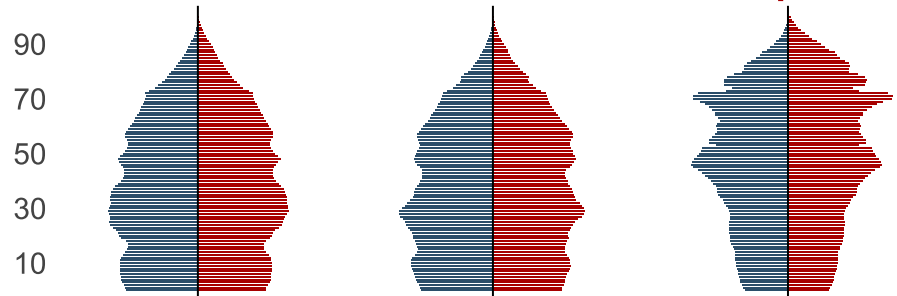
United States



Australia

New Zealand

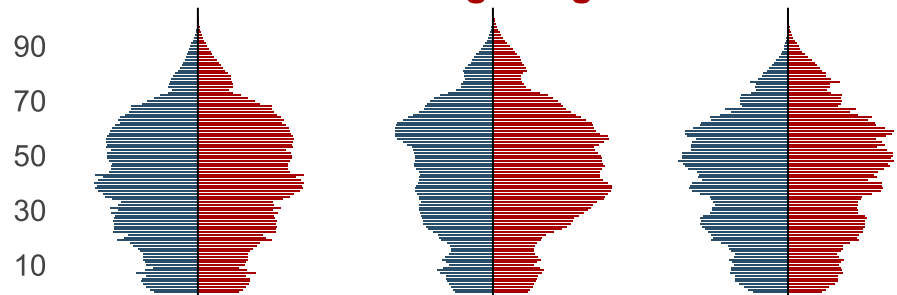
Japan



Taiwan

Hong Kong

South Korea



■ Male ■ Female

The populations have all aged substantially over time

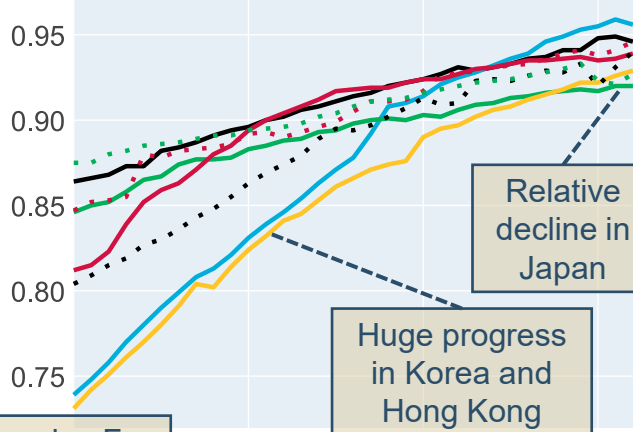
Age and gender distributions vary considerably between the populations

	Average Age	
	Male	Female
United Kingdom	39.7	41.4
Netherlands	40.8	42.5
United States	38.0	40.0
Australia	37.9	39.5
New Zealand	37.5	39.1
Japan	45.5	48.7
Hong Kong	43.5	44.4
Taiwan	40.5	42.3
South Korea	40.8	43.1

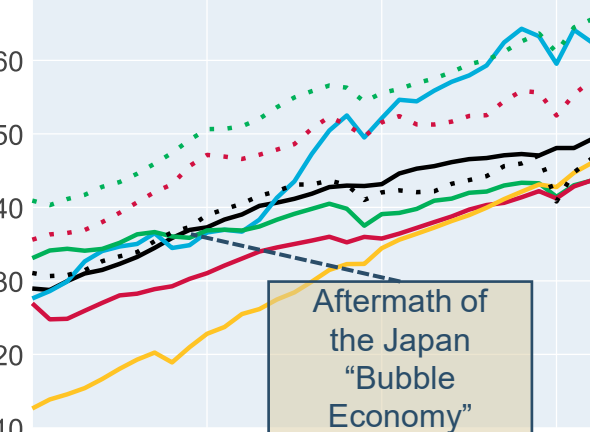
Socio-economic metrics associated with longevity³



Human Development Index



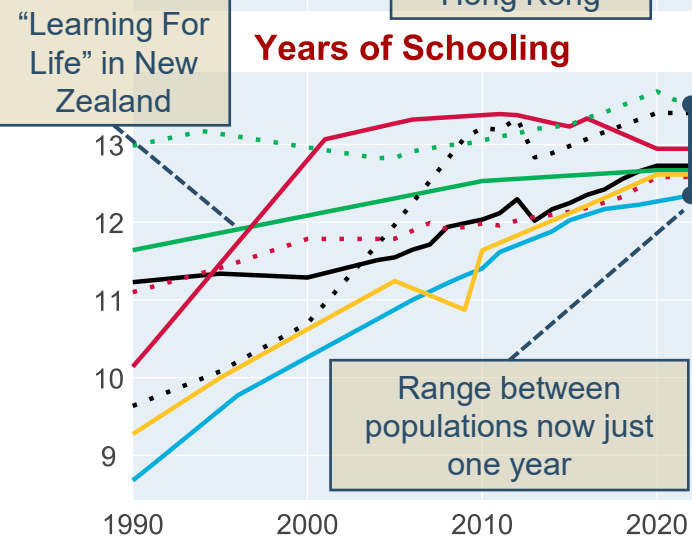
Income (2017 PPP\$k)



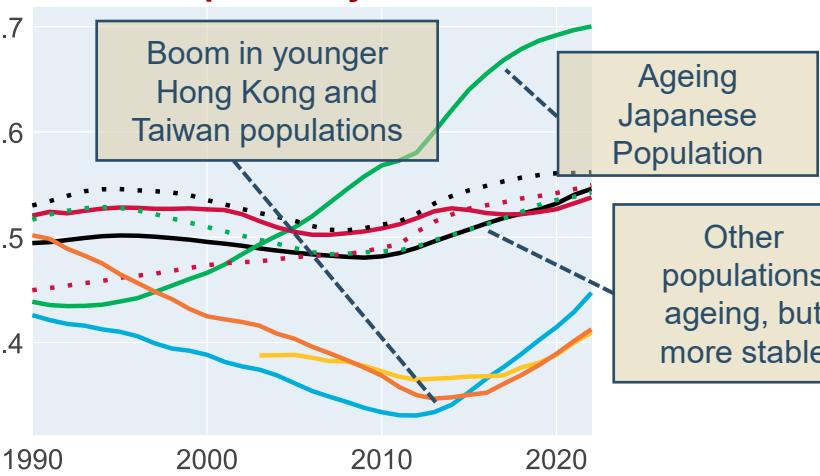
HDI: UN metric based on life expectancy, education, and income.

Standard of living proxied by income per capita.

Years of Schooling



Dependency Ratio



Average years of schooling at ages 25+ assesses education.

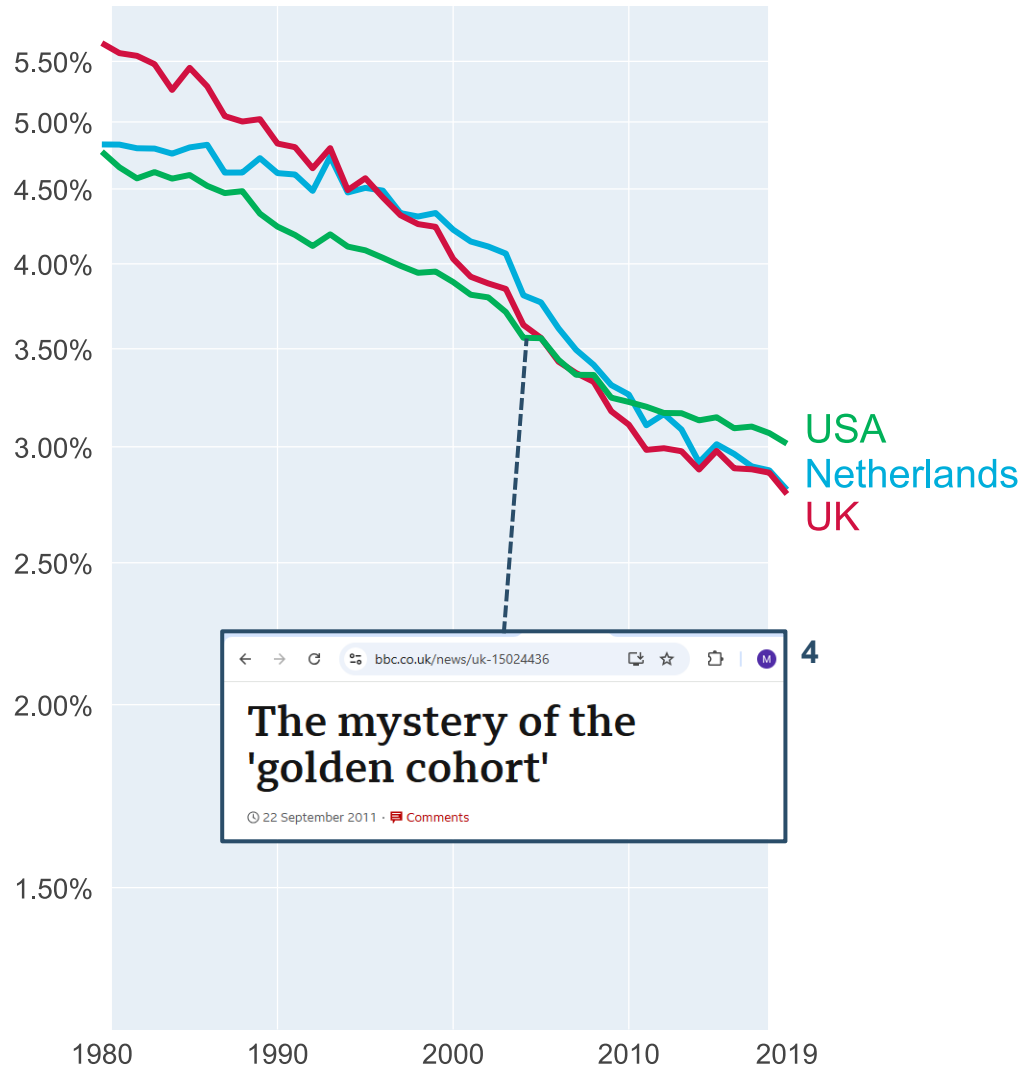
Dependency ratio: proportion of the population out of versus within working age range.

- · United Kingdom · · United States · · New Zealand · · Hong Kong · · South Korea
- · Netherlands · · Australia · · Japan · · Taiwan

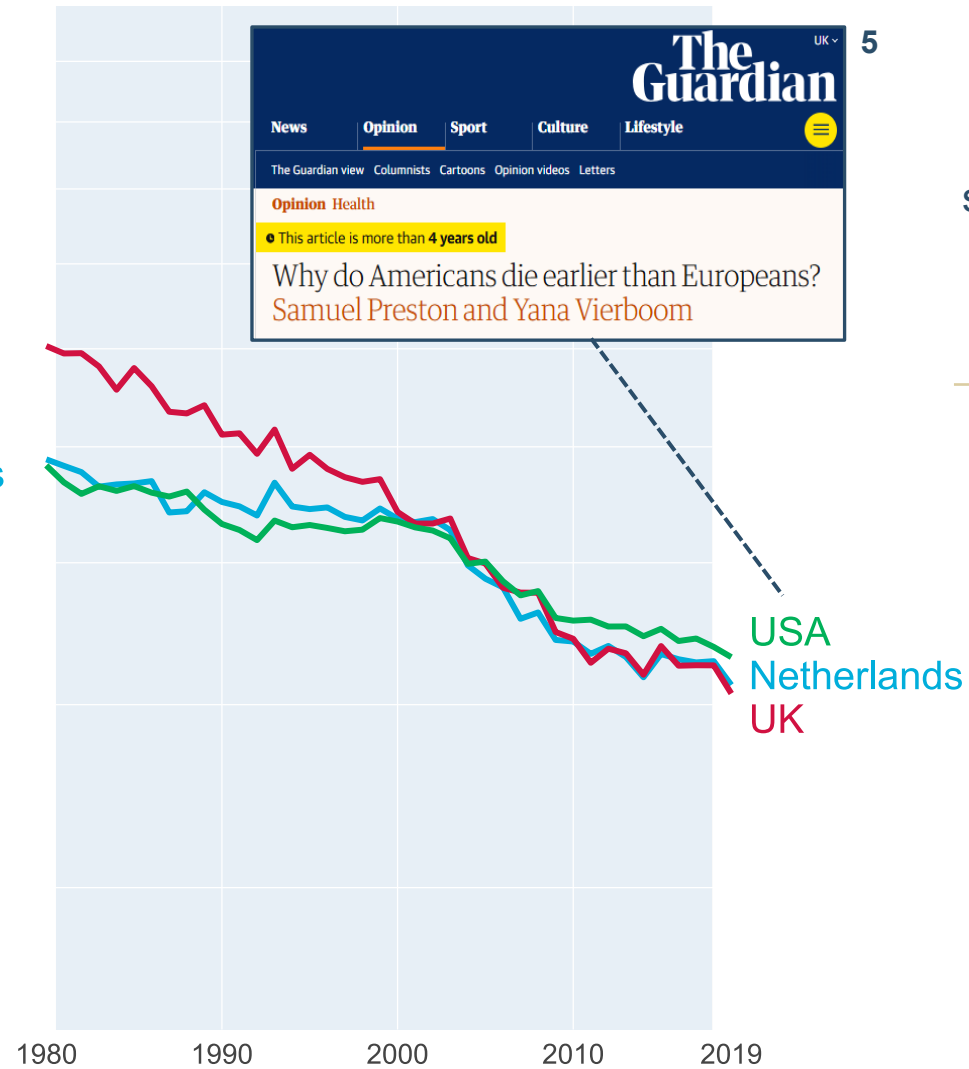
ASMRs: European / North American populations



Male



Female



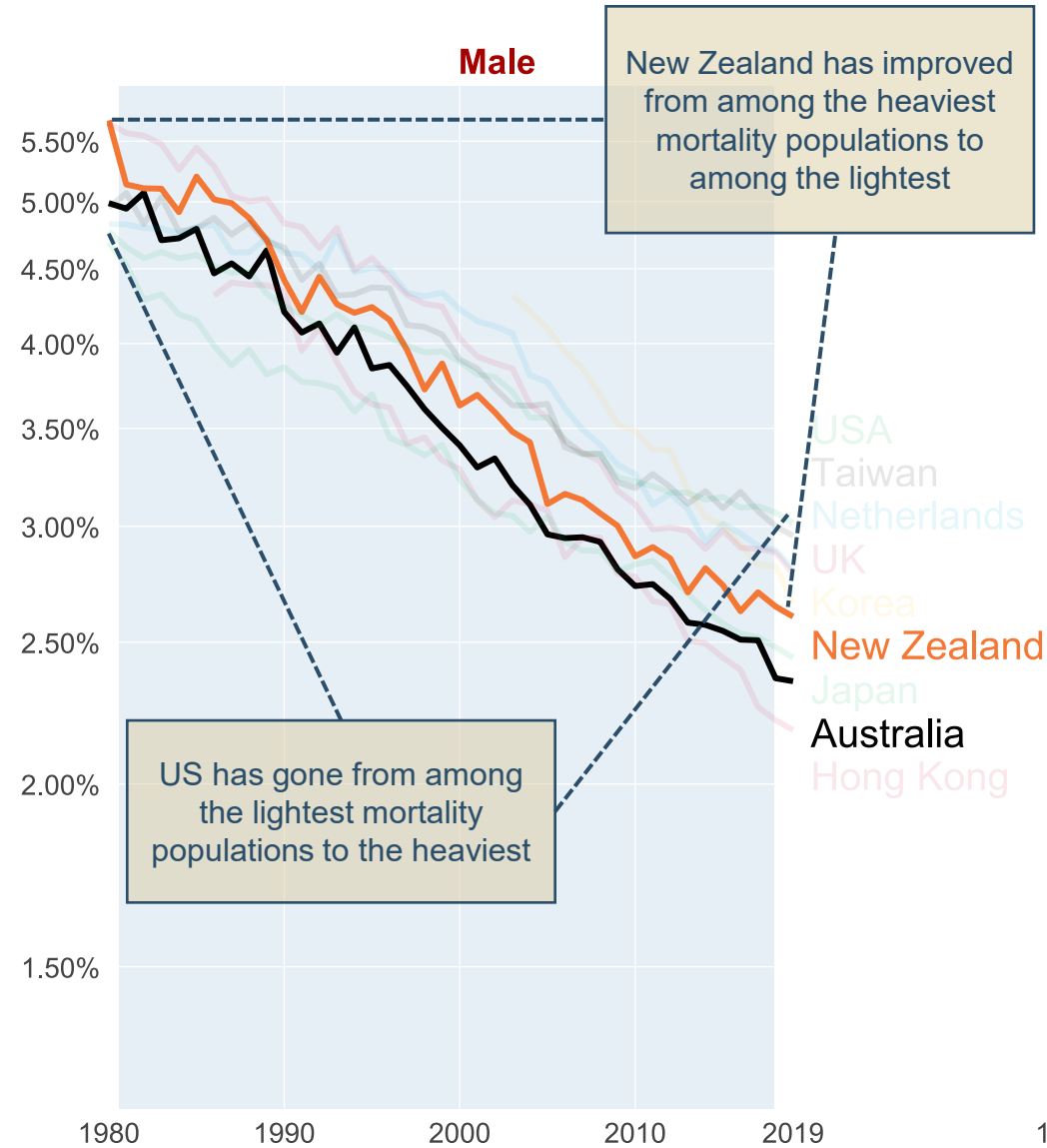
ASMRs control for shifting age profiles, and allow comparison between populations

The log scale means trends between populations can be directly compared

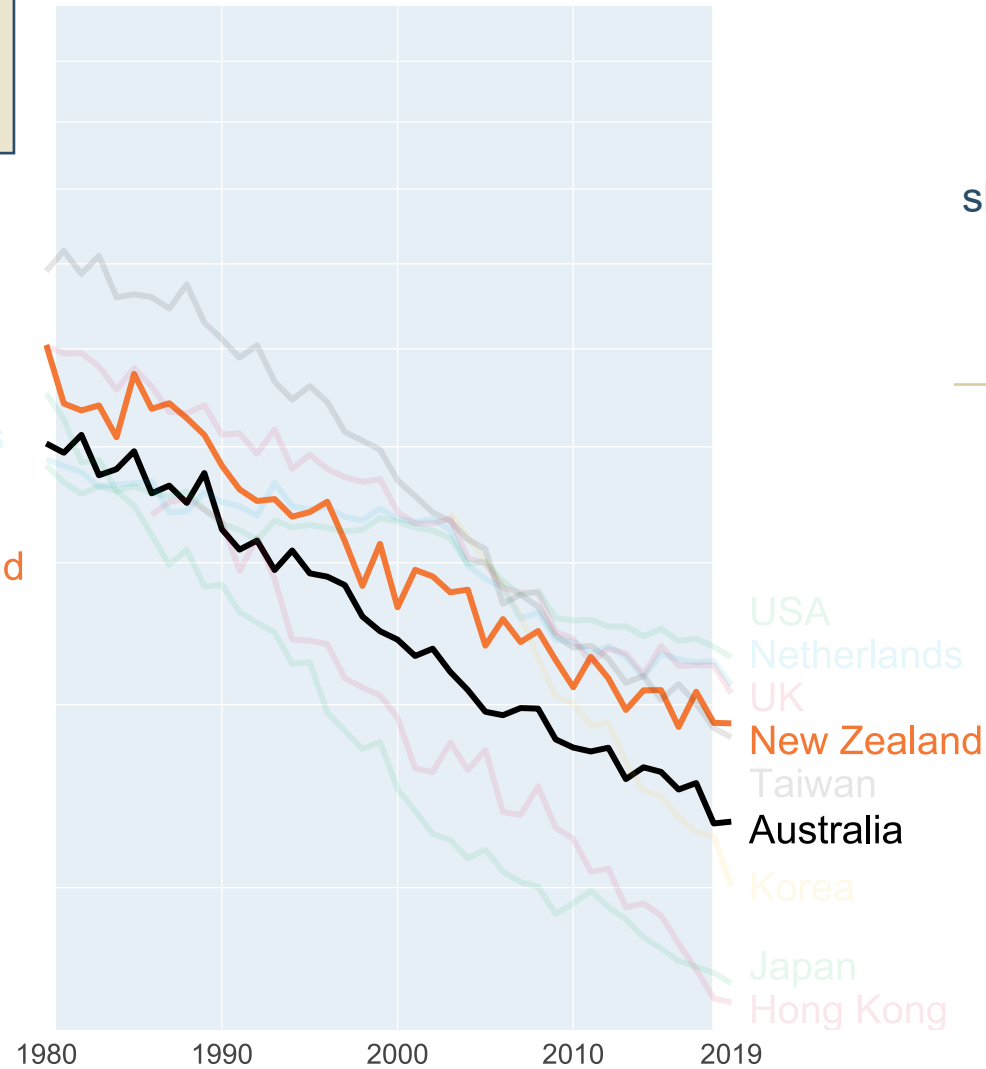
ASMRs: Asia-Pacific populations



Male



Female



ASMRs control for shifting age profiles, and allow comparison between populations

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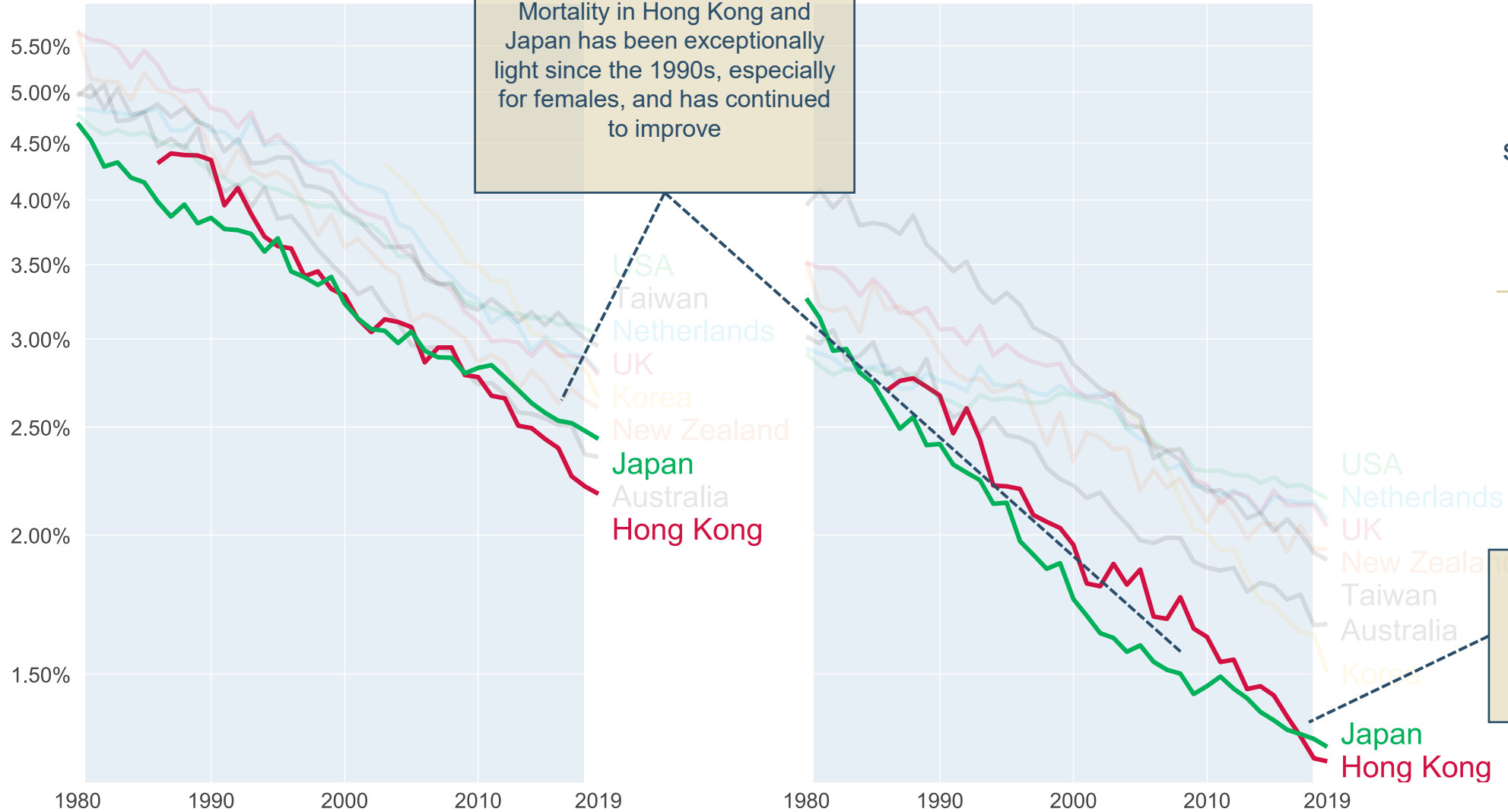
ASMRs: Asia-Pacific populations



Male

Female

Mortality in Hong Kong and Japan has been exceptionally light since the 1990s, especially for females, and has continued to improve



ASMRs control for shifting age profiles, and allow comparison between populations

The log scale means trends between populations can be directly compared

Is it reasonable to assume that strong mortality improvements will continue, and mortality levels will diverge further for these populations?

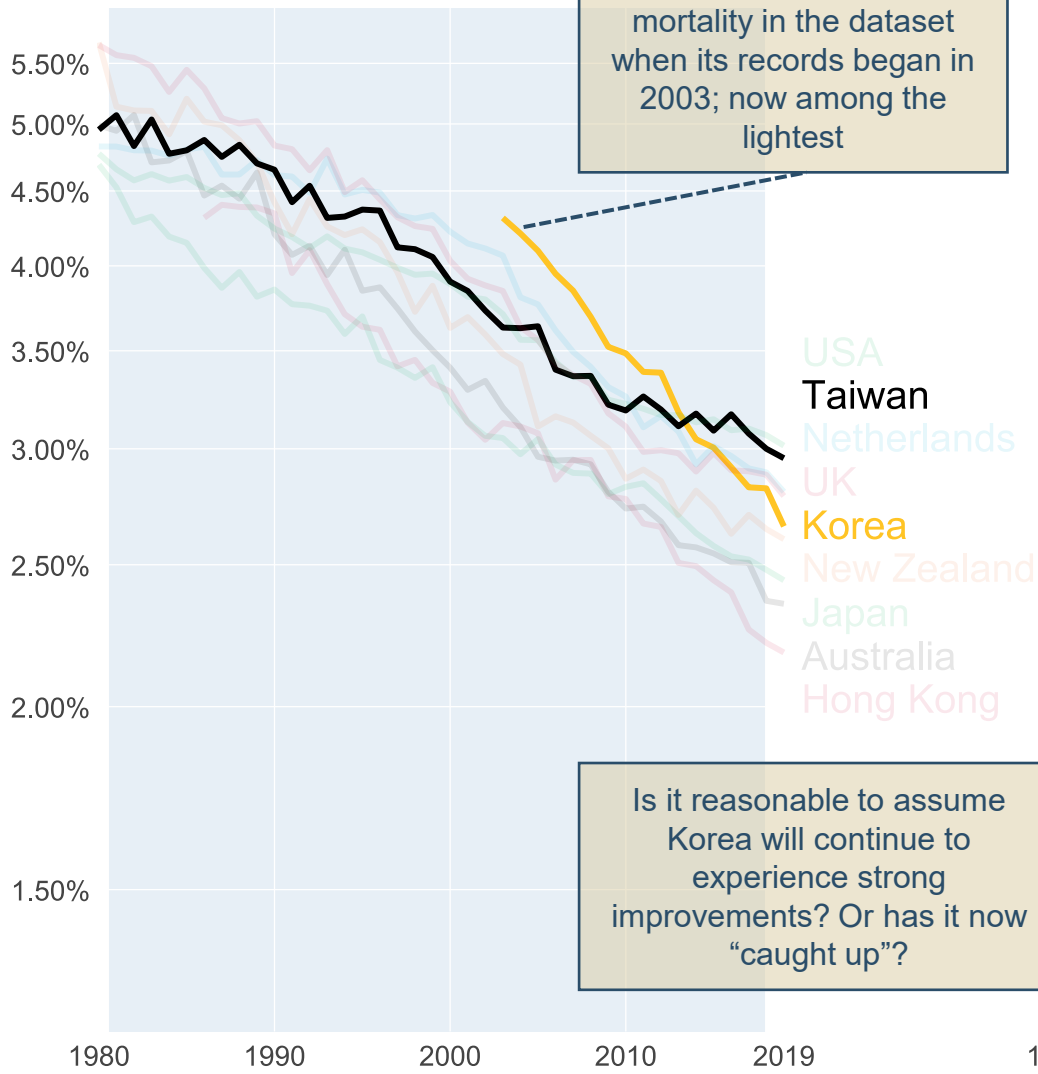
ASMRs: Asia-Pacific populations



Male

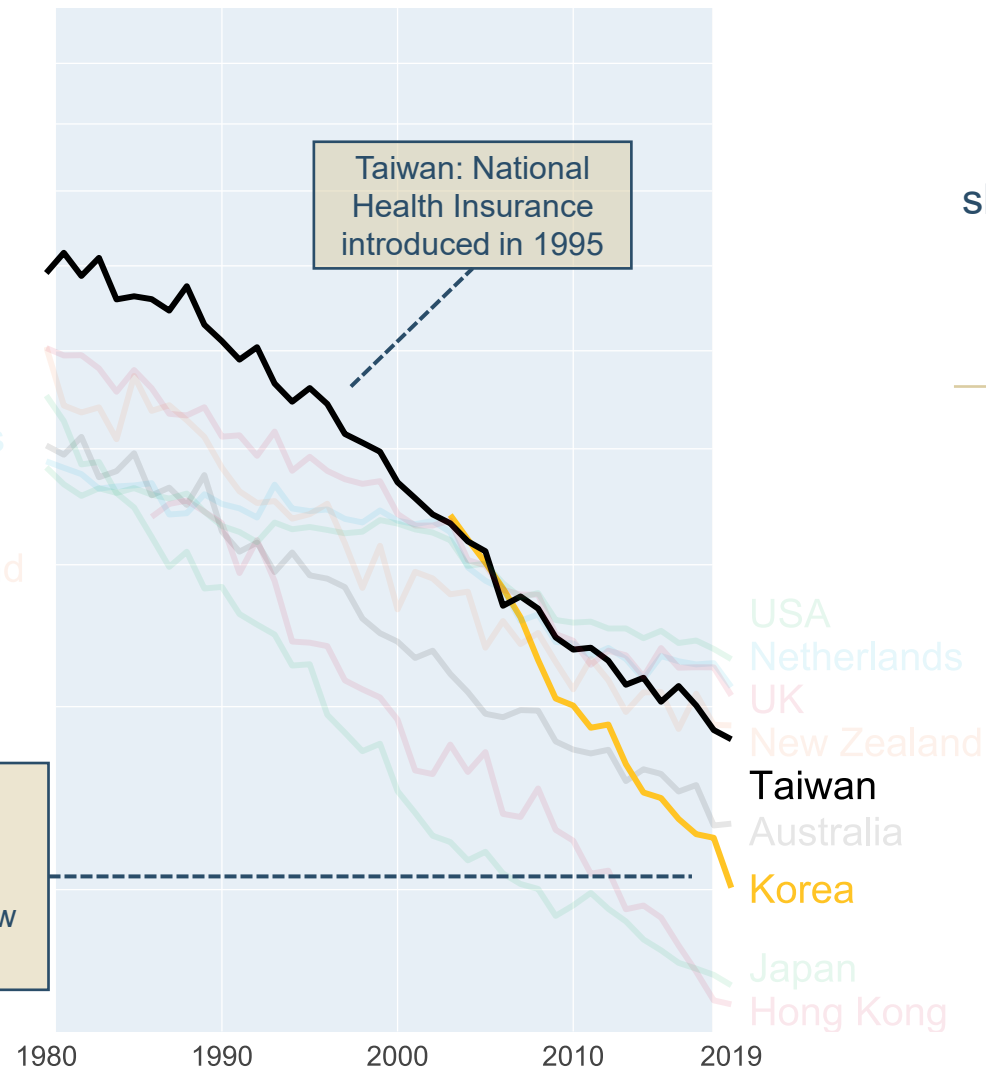
Korea had the heaviest mortality in the dataset when its records began in 2003; now among the lightest

Is it reasonable to assume Korea will continue to experience strong improvements? Or has it now "caught up"?



Female

Taiwan: National Health Insurance introduced in 1995



ASMRs control for shifting age profiles, and allow comparison between populations

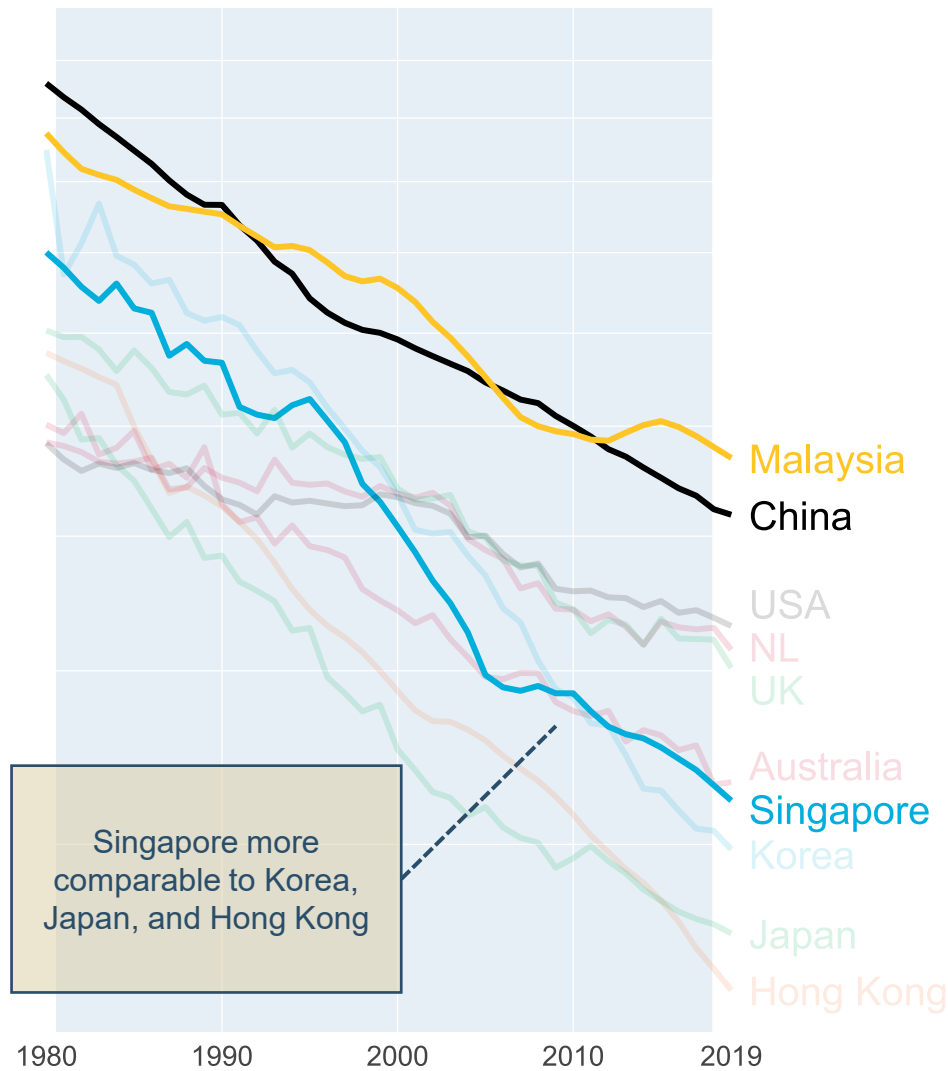
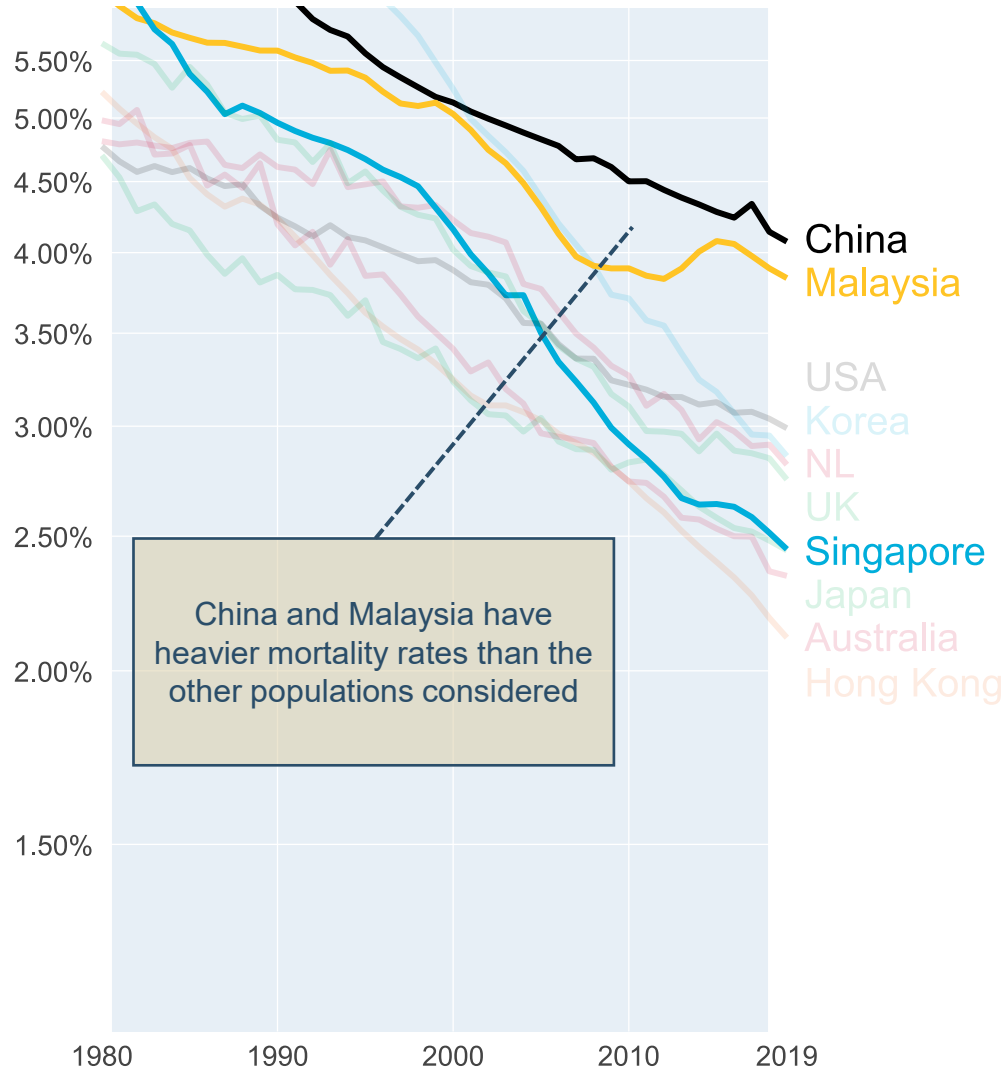
The log scale means trends between populations can be directly compared

ASMRs: Asia-Pacific populations (not included in HMD)



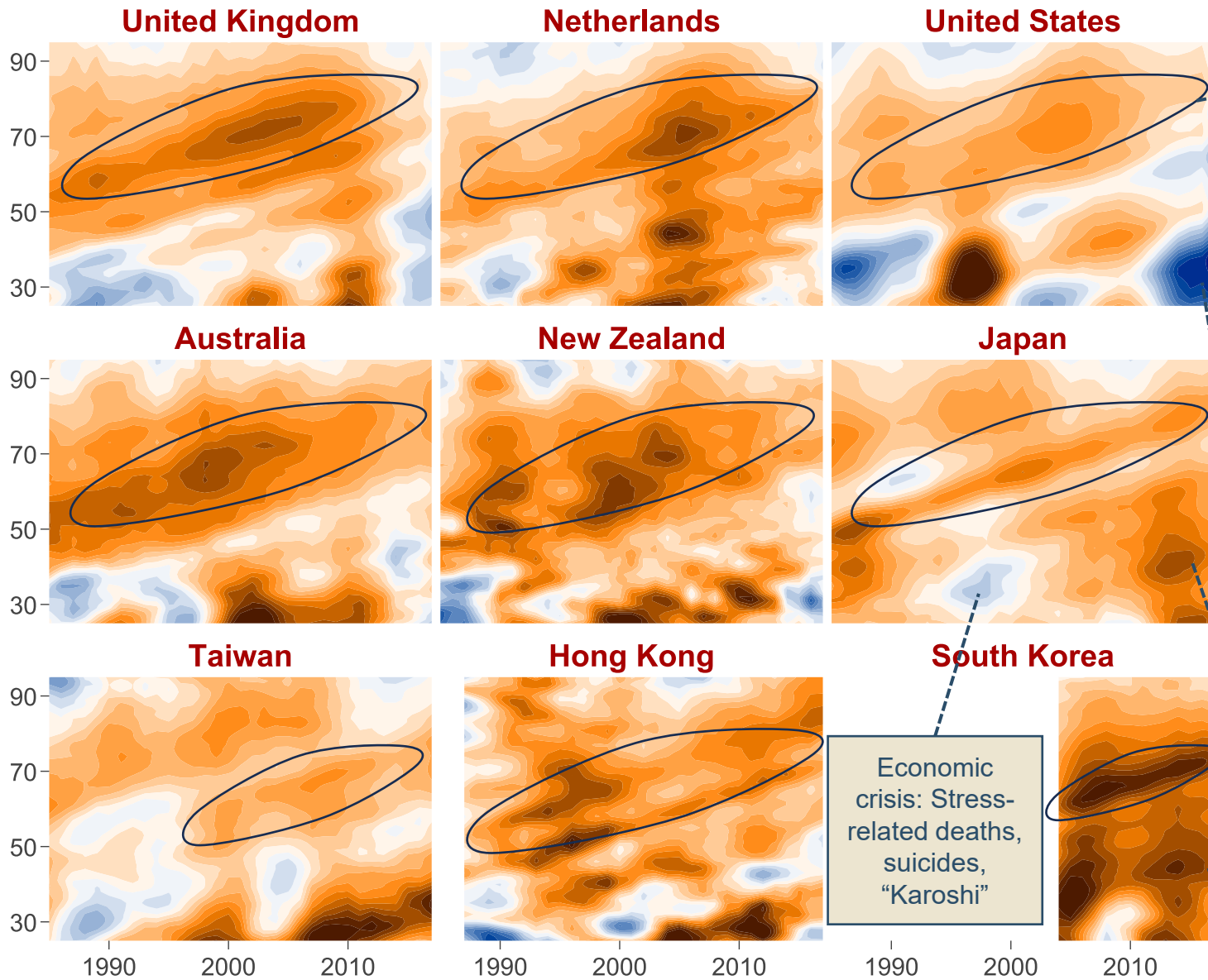
Male

Female



UN estimates⁶ not directly comparable to HMD

Heatmaps: Males



“Golden Cohort” – lives born between around the 1930s

Heatmaps show trends by age and calendar year, with improvements shown in amber and deteriorations in blue

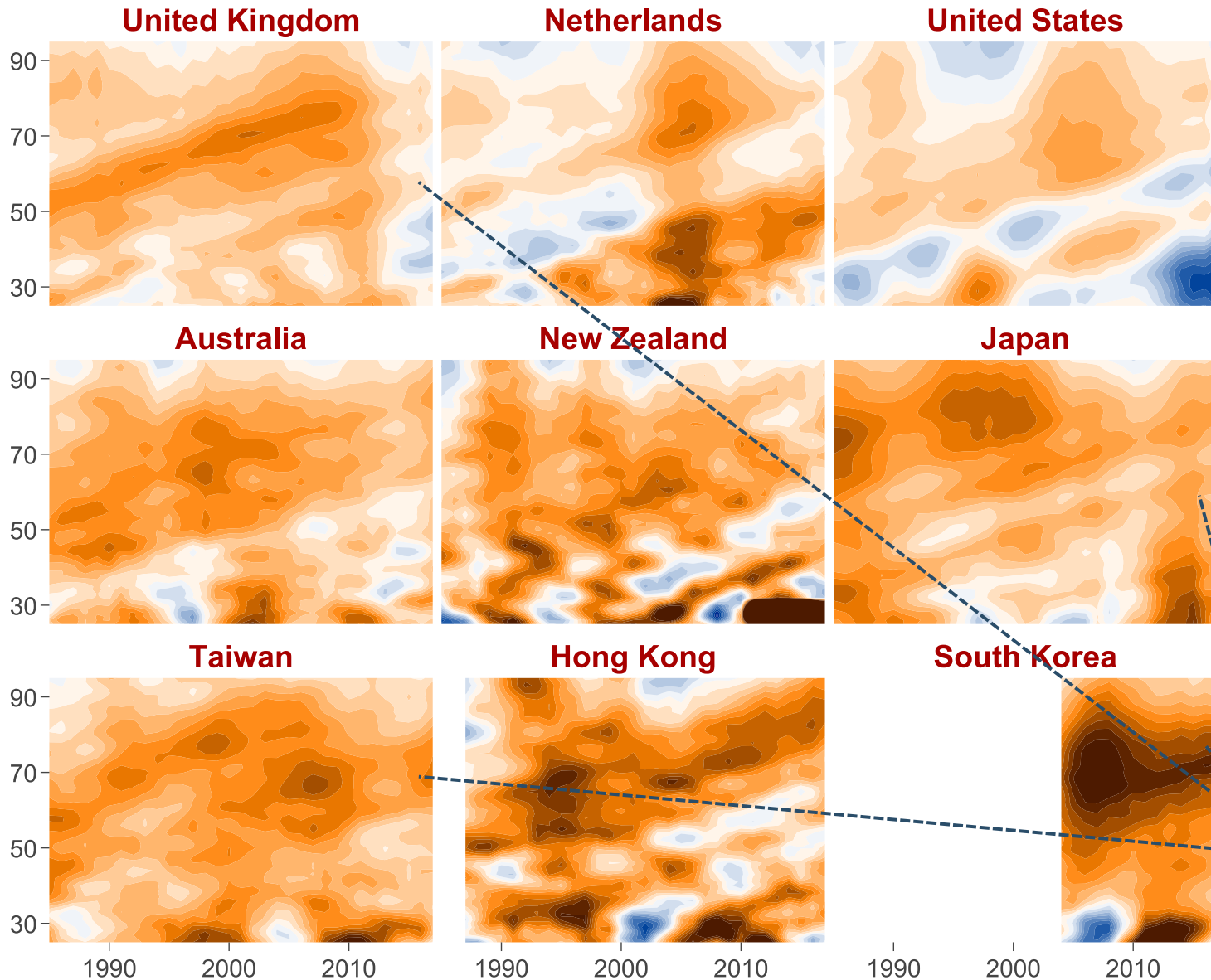
We apply a smoothing kernel to the raw data, to reduce the noise and represent the trends in an unstructured way

Diagonal patterns (cohort effects) are a feature for all of the populations

Economic crisis: Stress-related deaths, suicides, “Karoshi”

Opioid crisis – feature in US but not in Asian countries

Heatmaps: Females



Heatmaps show trends by age and calendar year, with improvements shown in amber and deteriorations in blue

We apply a smoothing kernel to the raw data, to reduce the noise and represent the trends in an unstructured way

Diagonal patterns (cohort effects) are a feature for all of the populations

Strong sustained improvements in Asian populations (unlike slowdowns in UK, US)

Industry models provide a toolkit for projecting the trends



Model	Initial improvements	Projected improvements
<p>CMI⁷ United Kingdom (Pre-2025)</p>	<p>APCI Model</p> $\log m_{x,t} = \binom{\text{Age}}{\alpha_x} + \binom{\text{Age \& Period}}{\beta_x(t - \bar{t}) + \kappa_t} + \binom{\text{Cohort}}{\gamma_{t-x}}$ <p>Parameters calibrated to data subject to smoothing constraints</p>	<p>Converge to user-defined long-term assumptions</p>
<p>AG⁸ Netherlands</p>	<p>Li-Lee Multi-Population Model</p> $\log \mu_{x,t} = \binom{\text{Population 1 (e.g. Western Europe)}}{\binom{\text{Age}}{A_x} + \binom{\text{Age \& Period}}{B_x K_t}} + \binom{\text{Population 2 } \Delta \text{ vs 1 (e.g. Netherlands)}}{\binom{\text{Age}}{\alpha_x} + \binom{\text{Age \& Period}}{\beta_x \kappa_t}}$ <p>Parameters calibrated to data</p>	<p>Period (K and κ) terms projected with time series techniques</p>
<p>MIM⁹ United States</p>	<p>Whittaker-Henderson smoothing of mortality rates</p>	<p>Converge to user-defined long-term assumptions</p>

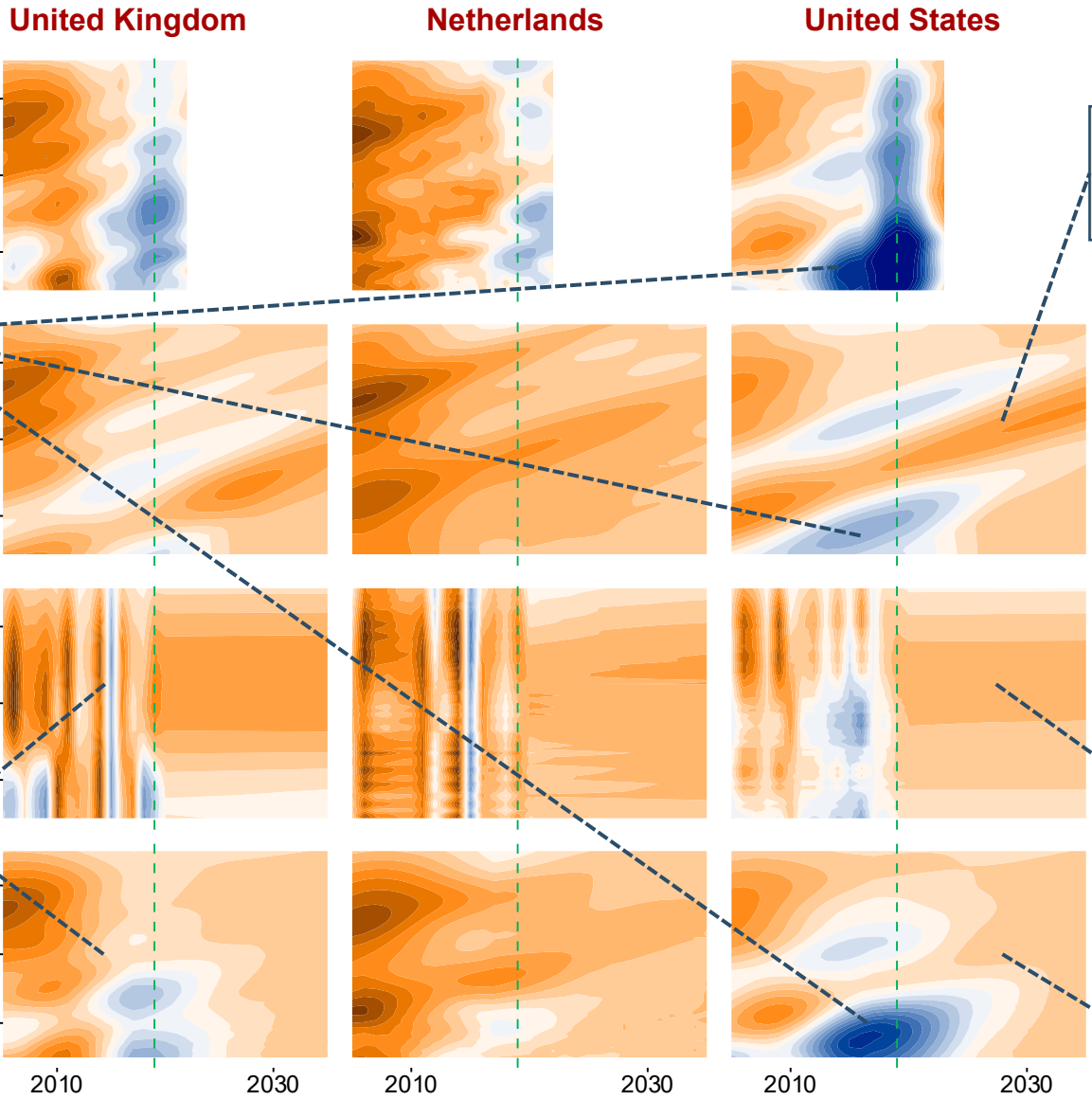
Each of the models requires some judgement in its application



Model	Implementation
CMI	Fit to each population separately, with core parameters; LTR 1.5%
AG	UK: α/κ based on UK data. APAC: A/K based on APAC region, α/κ based on each sub-population USA: based on USA data
MIM	Apply WH smoothing method to each population Same long-term rates as with CMI. 50:50 horizontal/diagonal convergence
All	Fit with data up to 2019, to avoid inclusion of Covid-19 impacted years



Differences in projection



Extent to which the models capture features

Implied levels of smoothing

Projected cohort effects

Top panels as on slide 11, but include more recent years' experience

Dotted green line indicates "transition point" between calibration period and projection in 2019

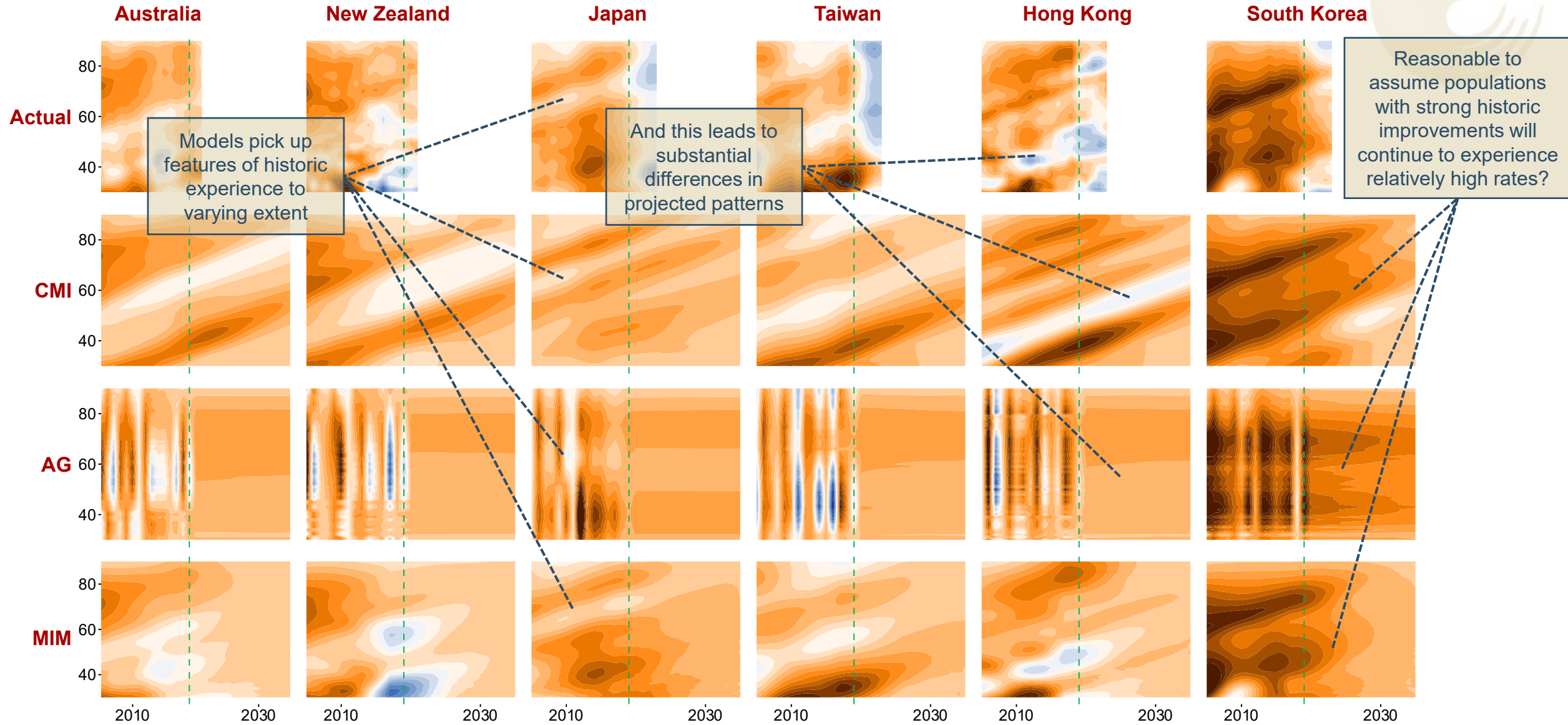
Corresponding graphs for females shown in appendix

No cohort component

Mixed approach to cohort effects



Applying the models to Asia – Pacific populations (males)



What could this mean in terms of projected mortality rates?



Wide range between projected improvements for each population

	Males			Females		
	CMI	AG	MIM	CMI	AG	MIM
United Kingdom	90	82	89	89	83	89
Netherlands	85	86	85	91	84	89
United States	92	87	91	89	89	90
Australia	86	80	85	84	74	86
New Zealand	90	81	88	88	72	88
Japan	82	81	84	83	75	84
Taiwan	87	80	86	81	77	83
Hong Kong	80	80	83	76	75	81
South Korea	73	74	77	71	67	76

Table shows projected mortality levels (ASMRs) in 2030 as a % of 2019 levels

e.g. a result of 85% would imply average improvements of about 1.5% from 2020-2030

$$1 - \exp\left(\frac{\log(0.85)}{11}\right) \approx 1.5\%$$

Less wide, but also substantial, range between models applied to each population

What could this mean for valuation of annuities and pensions?

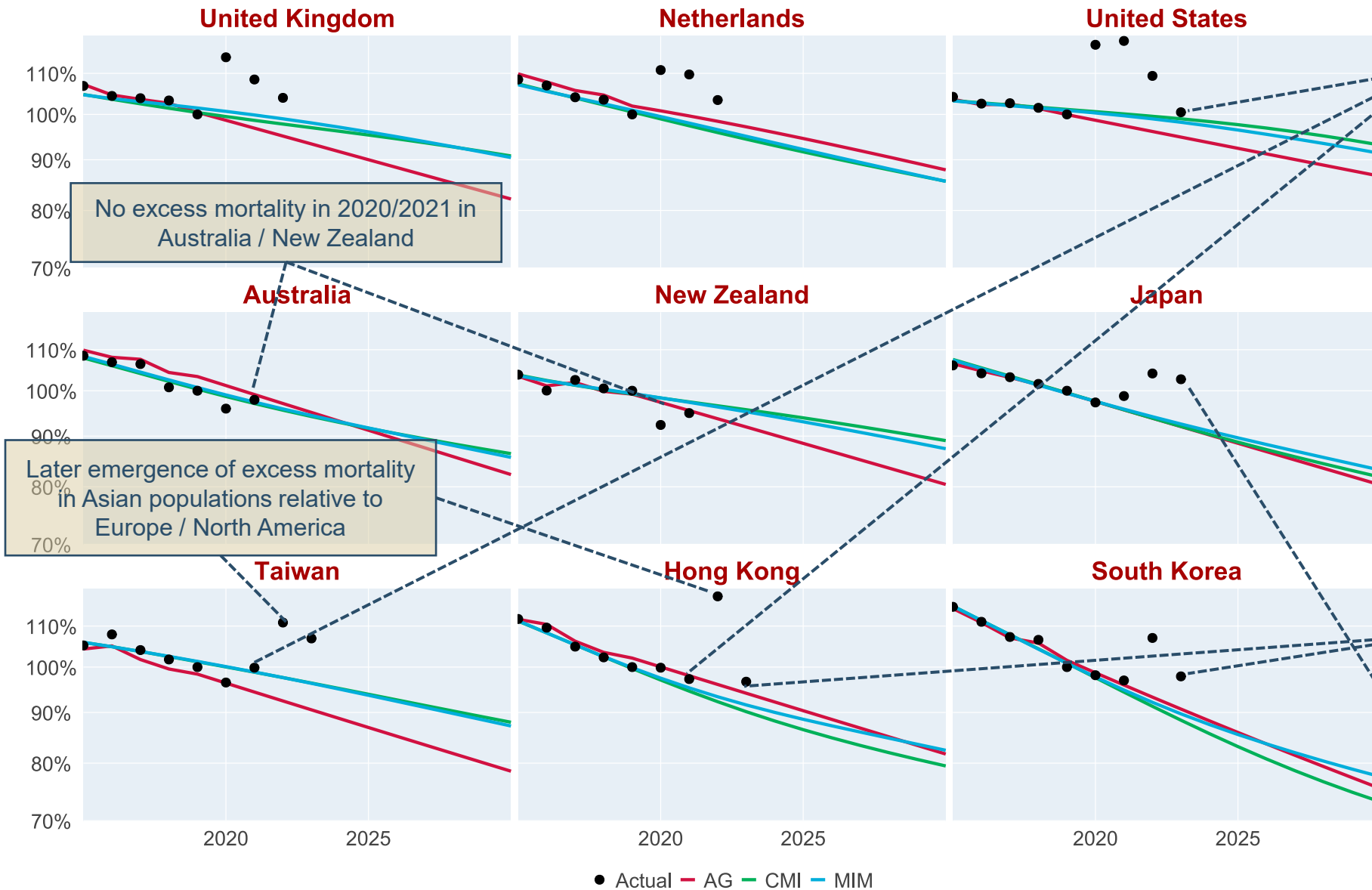
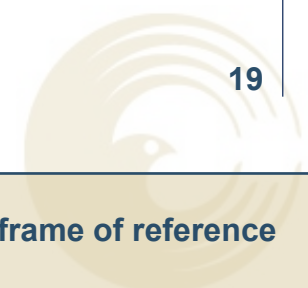
		Age 55		Age 70		Age 85		Portfolio	
		AG	MIM	AG	MIM	AG	MIM	AG	MIM
Australia	Male	+3.4	+1.1	+1.7	+0.9	-1.1	+15	+2.3	+0.2
	Female	+2.8	-0.2	+2.6	-0.8	+2.3	+18		
New Zealand	Male	+3.9	+1.3	+3.0	+1.0	+3.5	+1.4	+3.8	+0.5
	Female	+4.0	+0.4	+4.0	-0.7	+5.4	+1.2		
Japan	Male	+1.3	-0.1	+0.9	-1.4	-0.9	-0.2	+1.2	-0.5
	Female	+1.9	-0.1	+1.7	-0.5	+0.8	-0.2		
Taiwan	Male	+4.8	+1.1	+3.9	+0.7	+2.5	+0.0	+2.8	+0.1
	Female	+2.0	-0.2	+1.3	-0.7	+2.1	-0.7		
Hong Kong	Male	+2.0	+0.1	-0.6	-1.0	-3.2	+0.2	+0.2	-0.6
	Female	+1.4	-0.6	+0.3	-1.0	-2.4	-0.6		
South Korea	Male	+1.0	-1.4	-0.7	-1.7	-1.1	-0.5	+0.8	-1.3
	Female	+1.7	-1.1	+1.5	-1.5	+1.5	-0.1		

Wide range of results – model selection and calibration risk

Table shows present value of projected whole-of-life annuities relative to CMI model projection (in %), based on mortality rates projected by the models

Assumes real interest rates of 2% and high-level illustrative demographic mix

What has happened since 2019?



No excess mortality in 2020/2021 in Australia / New Zealand

Later emergence of excess mortality in Asian populations relative to Europe / North America

Importance of frame of reference

In line with pre-pandemic expectation, or excess mortality?

Graph shows actual and projected ASMRs relative to 2019 levels

Graph relates to males; Similar patterns for females, shown in appendix

Some evidence of recovery?

Or not?



Populations in the Asia-Pacific region have variety in demographic and socio-economic profiles, and these differences have also varied over time



Historic mortality improvements have been very strong in these populations relative to European and North American reference populations



Some drivers of mortality improvements have had global impacts (e.g. “golden cohorts”) whereas others are population-specific (e.g. Japan economy, US opioid crisis)



There is variation in the output of the models, and model selection and calibration could have material impacts on valuation of annuity / pension business

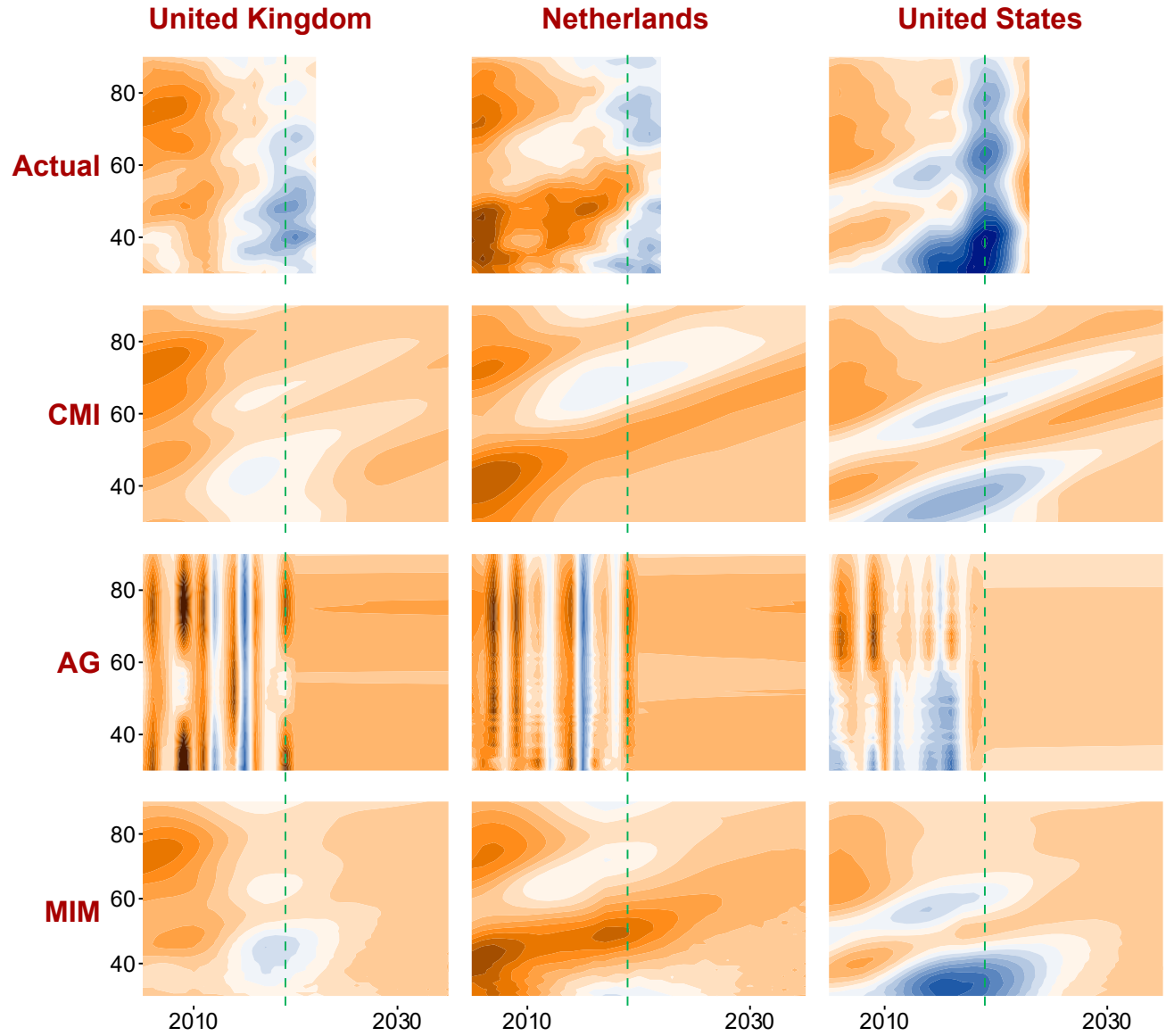


Mortality experience since onset of Covid-19 pandemic has been heterogeneous between populations. Insights from international populations can help, but approaches in one population might not easily be applicable to other regions



1. Mortality data sourced from Human Mortality Database: www.mortality.org
2. 2023 European Commission standard reference population: <https://ec.europa.eu/eurostat/web/products-manuals-and-guidelines/-/ks-ra-13-028>
3. Human Development Index: <https://hdr.undp.org/data-center>
4. BBC News: The mystery of the 'golden cohort' <https://www.bbc.co.uk/news/uk-15024436>
5. The Guardian: Why do Americans die earlier than Europeans? <https://www.theguardian.com/commentisfree/2021/may/04/why-do-americans-die-earlier-than-Europeans>
6. UN Mortality Data: <https://www.un.org/development/desa/pd/content/mortality-0>
7. CMI Mortality Projections Model: <https://www.actuaries.org.uk/learn-and-develop/continuous-mortality-investigation/cmi-investigations/mortality-projections>
8. AG2024 Mortality Projections Table: <https://www.actuarieelgenootschap.nl/kennisbank/prognosetafel-ag2024-2>
9. SOA Mortality Improvements Model: <https://www.soa.org/resources/research-reports/2023/mortality-improvement-model>
10. Analysis and modelling produced with R software, R Project for Statistical Computing: <https://www.r-project.org/>

Appendix: Applying the models to each others' datasets (females)

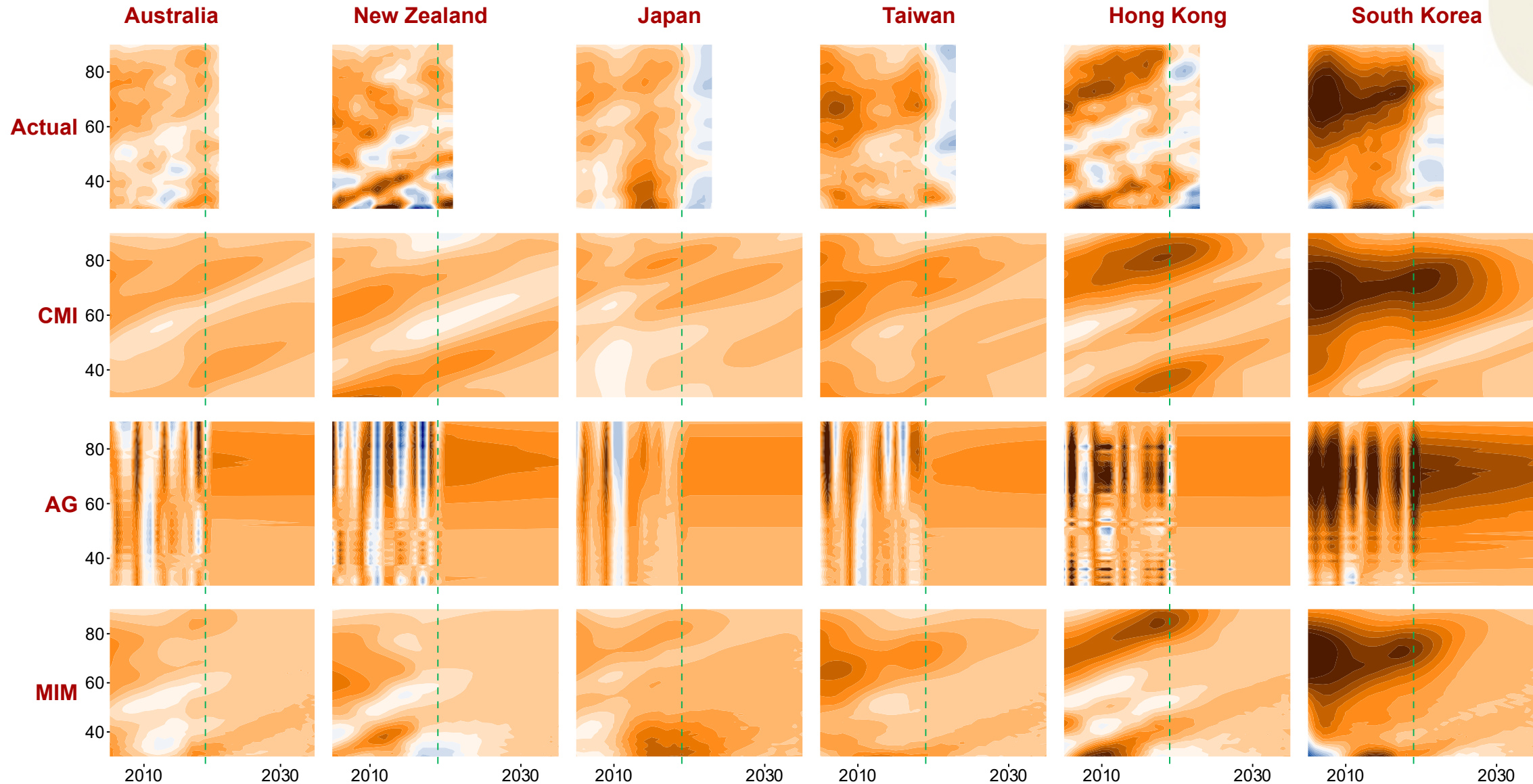


Top panels as on slide 12, but include more recent years' experience

Dotted green line indicates "transition point" between calibration period and projection in 2019

Corresponding graphs for males shown in body of report

Appendix: Applying the models to Asia – Pacific populations (females)



Appendix: What has happened since 2019 (females)?

